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CAUSE OR CHANCE?

In a recent address before the staff of the Bureau of Standards, Dr. Paul R. Heyl discussed the change of attitude that has recently occurred among scientific men with regard to the law of cause and effect. Many of the fundamental principles of nineteenth century science have been discarded or radically altered, but it has been reserved for recent years to attack this most fundamental principle of all.

Scientific thought ever since such a thing has existed has postulated a universe of law and order, not only on the large scale where such law may be observed but also on the subatomic scale where it has been assumed. The new view recognizes law on the large scale, but denies it on the scale of electronic action. Perhaps the best illustration of this new thought is one based on the behavior of human individuals. Individually, man is somewhat of an enigma; one can never say with certainty what any particular person will do next. But with a million or so individuals this uncertainty disappears. We can safely predict how many of them will take any particular course of action. In the mass, man is a mathematical problem.

Something very like this is the latest turn in scientific philosophy. Dirac speaks of "the free will of nature," meaning that electrons individually may not be governed by the law of cause and effect, but in large numbers law may make its appearance.

Doctor Heyl quoted de Broglie, the founder of the theory of wave mechanics, as saying that whatever may be the final fate reserved for these new doctrines, it is of infinite interest to philosophers that scientists have been led, even though but for the moment, to doubt the law of cause and effect in nature.

HYDROGEN ISOTOPE OF MASS 2

For a long time it has been considered that the nuclei of all hydrogen atoms are the simplest and that the nuclei of all other atoms are composed of hydrogen nuclei and electrons. It has now been found by Harold C. Urey and G. M. Murphy, of Columbia University, in cooperation with F. G. Brickwedde, of the Bureau of Standards, that all hydrogen nuclei are not alike, but that about 1 in every 4,000 is itself built up of 2 ordinary hydrogen nuclei, protons, and 1 electron. It has, there-

fore, twice the weight of ordinary hydrogen and is called and isotope of hydrogen because it has the same chemical properties. Its occurrence in ordinary hydrogen is so small that it had to be concentrated before its detection and identification could be made certain. Calculations were made of the vapor pressures of the two kinds of hydrogen which showed that it could be concentrated by the fractional distillation of liquid hydrogen at a low pressure only slightly above its freezing point. Samples were prepared in which the concentration was increased to 1 in 500 or 600. The isotope was detected and identified by means of its spectrum produced by passing an electrical discharge through the gas. The spectrum was analyzed by means of a diffraction grating with a focal length of 21 feet.

HEAT OF VAPORIZATION OF WATER

A knowledge of the quantity of heat required to convert water into steam under saturation conditions is essential in the design of steam power plants. The bureau, in cooperation with the American Society of Mechanical Engineers, has been making a long series of measurements in the range from 50° to 270° C. Recent determinations at 50°, 70°, and 90° C. give values of 2,381.6, 2,333.6, and 2,283.4 international joules per gram, respectively.

The official report on this work will be published in the March number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

INFRA-RED ARC SPECTRUM OF PHOSPHORUS

The spectrum of an element is that one of its characteristics by which its identity is definitely and absolutely established. Very little is known about the arc spectrum of phosphorus, although this element plays such a prominent rôle in the chemistry of biological and industrial processes. The reason for this is that the prominent features of the spectrum lie either in the extreme ultra-violet or in the infra-red beyond the reach of ordinary spectrographic methods. Recently, at the bureau, that portion of the phosphorus arc spectrum, which lies in the infra-red, was photographed for the first time by means of specially sensitized plates prepared by the Eastman Kodak Co. About 40 new wave lengths have been measured, and these have been brought into relationship

with the ultra-violet lines already known as the result of the discovery of some additional ultra-violet lines. The analysis of the wave-length data shows that the spectrum agrees in all respects with that required theoretically for the phosphorus atom, with 15 electrons outside the nucleus, 5 of which are responsible for the observed spectrum. The ionization potential has been found to be 11.11 volts.

Those interested will find a complete report of this work in the March number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

OXIDATION OF ALDOSE SUGARS BY BROMIDE WATER

The oxidation of the aldose sugars to monobasic acids by bromine water is one of the classical reaction which has been considered as evidence for the aldehydic structure for glucose and related sugars. In a recent investigation at the bureau, bromine oxidations of various sugars were followed by the optical rotations of the solutions. A series of remarkable changes was found from which it was concluded that the sugars are not oxidized to the sugar acids as previously believed. The delta lactones are the first products which can be detected by means of the optical rotations. The acids which appear subsequently are secondary products resulting from the hydrolysis of these lactones. If the fact that the lactone formation precedes the formation of gluconic acid is interpreted to indicate that one ring form of the sugar is oxidized directly to the lactone, it can not be said whether or not the particular form of the sugar which is oxidized is the predominating form in solution. Nevertheless it is of interest that the delta or 1, 5 lactone is found in solution after the oxidation of a solution containing normal glucose which supposedly contains a 1, 5 ring structure. A complete report of this study will appear in the March number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

DESIGN OF DOMESTIC GAS BURNERS

Investigations covering 16 years at the Bureau of Standards have shown that there are four important conditions which should be fulfilled by a domestic gas burner: It should not go out, it should not flash back, it should be an efficient heat producer, and it should not produce carbon monoxide. On first thought it may appear a simple matter to design a burner which

will fulfill these conditions, but since they are all so interrelated and in some ways contradictory, and, moreover, are so influenced by other conditions of use, the matter of a satisfactory design is quite complicated and difficult.

The subject has only received attention during comparatively recent years. The first gas company in the United States was organized in Baltimore in 1816, but for at least 80 years gas was used almost entirely for lighting. Not until 1900 was gas employed to any extent for cooking, and it was not until 1916 (100 years after the introduction of gas into the United States), that the bureau was first called upon to study the design of atmospheric gas burners. During the World War when coal was difficult to obtain the use of gas for heating purposes became much more common than before, and owing to the use of poorly designed appliances a considerable number of accidents occurred. Since 1916 the bureau's work has, therefore, included a study of the efficiency and safety not only of the gas burner but of the appliance. The various factors which limit the design of gas burners, flashing back, lifting of the flame from the burner, and incomplete combustion which results in the liberation of either carbon monoxide or soot and yellow flame, may be plotted as curves, thus showing graphically the limits within which a successful burner must operate.

The apparatus used at the bureau in studying burners is designed to facilitate the determination of the proportions of a well-designed burner. The size of the ports is determined by the probable rate of gas consumption and the heat content of the gas as well as by the time allowable for a given heating operation. Having determined the size of ports, the throat area of the burner should be 40 per cent of the total port area and the length of the injection tube six times the throat diameter, the walls expanding with a 2° slope from the smallest diameter which occurs near the tip of the orifice through which the gas is injected into the tube. The air which is mixed with the gas in this tube is known as the primary air, but this air is never sufficient in amount to burn the gas completely. Secondary air must, therefore, have free access to the flame to complete the combustion. The shape of the burner, distance between the ports, and the distance from the burner to the uten-

sil are, therefore, important considerations.

As the result of this work it is possible to design an efficient and safe burner which will operate within any reasonable limits of gas consumption and composition. It is of interest to note that to meet widely different conditions, such as exist in communities served with natural and artificial gas, manufacturers are supplying burners of slightly different proportions, each best adapted to the gas available where they will be used. Atmospheric pressure, which varies with altitude, also has a slight effect, an appliance which would be perfectly satisfactory at Washington being not so well adapted to service in Denver, for instance. Atmospheric humidity has so slight an effect that it may be disregarded. This subject of gas-burner design has been in part discussed in Circular No. 394 which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents per copy; another paper in preparation will cover the remainder of the subject.

EFFECT OF HUMIDITY ON POWER OF INTERNAL-COMBUSTION ENGINE

The power which can be developed in an automotive engine is proportional to its mass rate of oxygen consumption.

This statement summarizes the results of research at the Bureau of Standards during the last 15 years and furnishes an interesting contrast to the complex formulas developed to account for the effects of various atmospheric factors on engine performance. This simple formula materialized when results of the final research, that of the effect of humidity, were considered, together with results of earlier work, on the effects of other atmospheric factors on engine performance.

Previous work had verified the quotation above over wide ranges of temperature and air pressure. The latest work, which will be discussed in a Technical Report of the National Advisory Committee for Aeronautics, has proved the truth of the summary over a wide range of humidity.

Although all of this work was done on the grounds of the bureau in Washington, the atmospheric conditions were artificially varied over such ranges that it is now possible to predict the performance of an engine anywhere on the surface of the earth—in the hot, dense atmosphere of Death

Valley; in the oppressive humidity of the tropics; or in the thin, cold air at the peak of Mount Everest.

The bureau's altitude laboratory, in which a portion of this work was done, is a testing chamber of such versatility that the entire sequence of experiments could have been made therein. The greater portion of the research was carried out, as a matter of convenience, in the automotive laboratory, where special apparatus was designed and constructed to enable the artificial control of atmospheric conditions. It was also necessary to develop a new type of psychrometer, capable of precise measurement of humidity over the extreme range used. This instrument will be described later in a Bureau of Standards publication.

WEATHERING OF SOLDERED AND TINNED SHEET COPPER

Accelerated weathering tests of tin and solder covered copper may be made in humid atmospheres containing 1 per cent SO_2 , 5 per cent CO_2 , and 94 per cent air by volume, if maintained around 50°C . or over. In the March number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH results are given in tabular form showing that tin and electroplated copper are but slightly attacked by the above atmosphere. On the other hand, heat-treated electroplated copper and hand-tinned copper are badly corroded and very badly pitted, while soldered copper, if heated to high temperatures previous to weathering, is markedly furrowed, resulting in a decrease not only of the strength of the sheet at the joint but also of the number of bends required to produce failure. The pitting is due to the formation of a brittle copper-tin layer which, upon cracking, exposes copper and forms with it the cathode of a galvanic cell. The furrowing of copper at the solder-copper junction is also due to similar galvanic action.

Microscopic study revealed that the copper alloyed with the molten tin of the tin coating or of the solder to form definite layers. The layers of tin-copper alloys adjacent to the sheet became richer in copper the higher the temperature used during tinning or soldering. The pitting of copper caused by galvanic action set up between these copper-rich alloys was considerable. At lower temperatures, less alloying occurred, with the result that the tin coat contained very little copper and the pitting and furrowing were markedly diminished.

Poor technique in the use of flux is not the cause of seam corrosion, but can cause pitting of copper. The prevention of seam corrosion and pitting of copper coated with tin-bearing materials lies in the prevention of the formation of copper-tin alloys. The corrosion can be reduced to a minimum by using low temperatures during tinning and soldering.

EFFECT OF ATMOSPHERIC MOISTURE ON THE DETERIORATION OF LEATHER CONTAINING SULPHURIC ACID

The effect of atmospheric moisture on the deterioration of leather containing sulphuric acid has been studied. Two lots of leather tanned in the bureau's experimental tannery with quebracho extract and two lots of leather furnished by commercial tanneries were used. Samples were treated so as to contain varying amounts of sulphuric acid up to 4 per cent. The tensile strength of each sample was then determined after conditioning at 65 per cent relative humidity. One-half of the leather was then aged at 65 and the other half at 85 per cent relative humidity. Selected samples were tested for strength after different aging periods up to two years. The change in strength of each sample during aging was taken as a measure of its deterioration. The average moisture content of the leathers was approximately 15 per cent at 65 per cent relative humidity and 18 per cent at 85 per cent relative humidity.

The rate of deterioration of the leather was found to be materially influenced by the amount of moisture in the atmosphere with which it was in contact. It was greater at the higher humidity and became more noticeable with increase in time and acid concentration. Leather, in service and in storage, is subject to normal atmospheric changes and its moisture content will vary accordingly. Therefore, these results demonstrate the importance of carefully controlling the sulphuric acid content of leather in the manufacturing processes.

STANDARD FOR BRAILLE PAPER

At the request of the Library of Congress a study was made at the bureau of Braille papers to be used in books for the blind. The results were reported last month, and will be used in the development of a purchase specification. There are no standards for such paper, and tests of 11 different papers, both printed and un-

printed, used by eight different printers, showed that a considerable variation exists. The special requirement of this paper is that the embossed points forming the printed characters must have sufficient resistance to crushing and yet not feel harsh to the sensitive fingers of the blind. The former property, tested by measuring the deformation of the character under a fixed load, was found to be closely related to the tensile breaking strength of the paper and its elongation under tensile stress. Detailed requirements for these properties, and for weight, thickness, and folding endurance were suggested.

BOND PAPERS FROM HIGHLY PURIFIED WOOD FIBERS

A study on a semicommercial scale has been made at the bureau of the manufacture of bond types of papers from commercial highly purified wood fibers, for uses requiring permanency (TECHNICAL NEWS BULLETIN No. 170; June, 1931). As a part of the investigation, the experimental papers produced were tested for strength, chemical purity, and aging properties. The strength tests included bursting, tensile, and tearing strength, and folding endurance. Those for chemical purity included alpha cellulose content, copper number, acidity, and quantitative tests for the sizing materials present. The accelerated aging test consisted of heating the papers in air to a temperature of 100° C. for 72 hours, and then measuring the extent of change in the various strength and chemical properties.

By studying the effects of variations in beating conditions on the properties of finished papers a method of beating well adapted for this kind of fiber was evolved. The papers possessed excellent strength, exceeding, in the case of the bond papers, the strength requirements of the highest grade bond papers purchased by the Government Printing Office, and, in the case of the currency type papers, the strength requirements for United States currency. The experimental papers also possessed other characteristics desirable in these types of papers.

Some of the possible factors influencing the aging properties, which arise in the process of converting pulp into paper, were studied, including effects of beating; alum (acidity), rosin, and starch used in beater sizing; and glue, starch, alum, and formaldehyde used for surface sizing. The amount of beating required to produce the desired characteristics in the pa-

pers had no apparent effect upon the chemical properties of the fibers or upon their stability. A definite relation between the acidity of the rosin-sized papers and their stability was noted. A marked lowering in stability was caused by the use of excessive amounts of alum. By careful control of the acidity of the stock in the beater (that is, amount of alum added to the beater), it was possible to prepare well-sized papers of very high stability. Other factors being alike, papers with the lowest rosin content had the best resistance to accelerated aging. In general, the addition of starch in the beater caused an increase in the strength of the paper, and had no deleterious effect upon the stability of the finished paper. The effects produced were practically the same for the two kinds of starch products used; one prepared by a process of acid hydrolysis, and the other by a process of oxidation.

Unsize and rosin-sized papers were surface sized with glue and starch solutions. In general, the bursting strength, tensile breaking strength, and elongation increased on surface sizing and the tearing strength decreased proportionally with the amount of size taken up by the basic paper. No such relation appeared to hold in the case of the folding endurance, which increased on surface sizing about 10 per cent on the average. In the case of the currency type papers, which had exceptionally high folding endurances before sizing, a slight decrease in folding endurance on surface sizing with glue was noted. For the specific samples of glue and starch used in this work, but little difference was noted in the final results. In general, the stability of the papers toward accelerated aging was improved by surface sizing. When alum was used in moderate amounts, as a preservative for the glue or starch in the surface-sizing baths, it caused no deleterious effect on the paper as far as could be determined by the tests applied.

A complete report of this study was published in the November number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH, and is now available as Research Paper No. 372. Copies can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents each.

PAPER FROM RAW COTTON

The prevailing low price of raw staple cotton is directing attention to

the possibility of using it for making paper. Cotton producers are interested in finding new or enlarged outlets for this material because the increasing use of synthetic fibers for textiles, and other adverse economic developments are leading to the accumulation of an increasing surplus of this important agricultural crop.

Next to the textile industry, the paper industry is the largest consumer of cellulose. In view of the many inquiries received by the bureau concerning the paper industry as a potential user of raw staple cotton, the question was discussed with various users of cotton fibre for paper making. The consensus of their opinions is as follows:

Raw staple cotton as produced at the present time can not compete with the highest grade of textile cotton wastes used for paper making as the price differential still favors the latter considerably, and any lowering of the price of staple cotton is reflected in the price of the textile wastes. There is considered to be no great difference in the way the two different classes of materials react in the paper-making processes or in the quality of paper prepared from them. Cotton linters, the shorter cotton strands left after removal of the staple cotton, and which is lower in price, is used to some extent in the paper industry but it appears to lack, for most purposes, some of the desirable paper-making properties possessed by the textile wastes.

From the above opinions, it appears that the use of raw staple cotton for paper making hinges largely on the economic factors, and probably the only way the present unfavorable cost ratio could be overcome would be by the production of the staple cotton on a generally mechanized basis. According to a recent news item, study in this direction is being made at the University of North Carolina. It is of interest that, according to historical records, raw cotton was the first source of cotton fibers for paper making, being largely used, apparently, from the seventh century until the eleventh century when it began to be displaced by waste textile materials.

MASONRY CEMENTS

The tests of the masonry cements outlined in *TECHNICAL NEWS BULLETIN* No. 174 (October, 1931) have brought out the great variation in their properties. Measurements were made of the spread upon a plate of the neat pastes dropped from an apparatus similar in principle to the

Saybolt viscosimeter. The ratio of the weight of cement to water to produce pastes having the same spread varies from 1:1 to 2.8:1. The apparent specific gravity of the pastes varied from 0.83 to 1.93. The apparent specific gravities of the mortars made from the cements have been found to range from 1.59 to 2.24. The variations in these specific gravities appear to be some function of the amount of waterproofing material contained in the cement and of the weight of the cement per unit volume.

When equal amounts of sand are added to equal amounts of pastes having the same neat spread the resulting mortar does not have equivalent flows on the flow table, these flows varying from 56 to 160. The range in seven-day compressive strength of a 1:3 by volume mix, using a mixture of standard and pit-run Ottawa sand as aggregate, varies from 15 to 4,085 lbs/in². The yields of the mortars vary considerably. The water requirement to produce a mortar flow of from 100 to 115 on the standard 10-inch flow table varied from 0.73 to 1.35 by volume. The cements requiring the greatest amount of water would not, as might be expected, give the greatest yield.

The plastic measurements on the modified McMichael viscosimeter varied from 510 to 2,360 for mortar mixes that all had a flow-table measurement of 100. Certain cement mortars show a decrease, some an increase, in flow-table measurement due to the mixing given in the plasticimeter, all mortars being given the same amount of agitation. Within the plastic limit the cements have a range of from 200 to 1,200 grams shear resistance. The amount of water that could be added to a cement and have the mortar remain within the plastic range varied from 5 to 6 per cent, with but few exceptions. This is true for cements requiring small amounts as well as large amounts of water. Thus at one extreme a cement was plastic with from 11 to 17 per cent water and at the other extreme a cement was plastic with from 24 to 29 per cent of water.

RELATION BETWEEN DENSITY AND REFRACTIVITY OF SOME GLASSES

The work on the relations between density and index of refraction of soda-silica glasses containing from about 50 to 80 per cent soda, has led to the conclusion that the changes in density and index of refraction with composition can be represented more accurately by straight lines than by

a single continuous curve. When the density or index of refraction of the soda-silica glasses is plotted against the silica or soda content of the glasses, there is a definite change in the slope of the line at points whose composition would correspond to soda-silica ratios 4:6, 3:6, and 2:6.

The relation between index of refraction and density is strictly linear and can be expressed by $N=1.8668-0.899V$, in which N is the index of refraction for yellow light and V is the reciprocal of density or specific volume. For glasses containing lime and magnesia the above equation holds if one adds to it 0.00114 times the percentage of lime and 0.00055 times the percentage of magnesia in the glass.

RADIO TRANSMISSIONS OF STANDARD FREQUENCY

The bureau transmits standard frequency signals from its station WWV, Washington, D. C., every Tuesday. The transmissions are on 5,000 kilocycles per second, and are given continuously from 2 to 4 p. m., and from 10 p. m. to 12 midnight, eastern standard time. (From October, 1931, to March, 1932, inclusive, the evening schedule was two hours earlier.) This service may be used by transmitting stations in adjusting their transmitters to exact frequency, and by the public in calibrating frequency standards and transmitting and receiving apparatus. The transmissions can be heard and utilized by stations equipped for continuous-wave reception throughout the United States, although not with certainty in some places. The accuracy of the frequency is at all times better than 1 cycle (1 in 5,000,000).

From the 5,000 kilocycles any frequency may be checked by the method of harmonics. Information on how to receive and utilize the signals is given in pamphlets obtainable on request to the Bureau of Standards, Washington, D. C.

The transmissions consist mainly of continuous, unkeyed carrier frequency, giving a continuous whistle in the phones when received with an oscillatory receiving set. For the first five minutes there are transmitted the general call (CQ de WWV) and announcement of the frequency. The frequency and the call letters of the station (WWV) are given every 10 minutes thereafter.

Supplementary experimental transmissions are made at other times. Some of these are made with modulated waves, at various modulation

frequencies. Information regarding proposed supplementary transmissions is given by radio during the regular transmissions, and also announced in the newspapers.

The bureau desires to receive reports on the transmissions, especially because radio transmission phenomena change with the season of the year. The data desired are approximate field intensity, fading characteristics, and the suitability of the transmissions for frequency measurements. It is suggested that in reporting on intensities, the following designations be used where field-intensity measurement apparatus is not used: (1) Hardly perceptible, unreadable; (2) weak, readable now and then; (3) fairly good, readable with difficulty; (4) good, readable; and (5) very good, perfectly readable. A statement as to whether fading is present or not is desired, and if so, its characteristics, such as time between peaks of signal intensity. Statements as to type of receiving set and type of antenna used are also desired. The bureau would also appreciate reports on the use of the transmissions for purposes of frequency measurement or control.

All reports and letters regarding the transmissions should be addressed Bureau of Standards, Washington, D. C.

NEW AND REVISED PUBLICATIONS ISSUED DURING FEBRUARY, 1932

Journal of Research¹

Bureau of Standards Journal of Research, vol. 6 (RP Nos. 259 to 328, inclusive), bound in cloth, \$2.75 (foreign, \$3.50).

Research Papers¹

(Reprints from Journal)

- RP357. Aqueous solutions of ethylene glycol, glycerin, and sodium silicate as quenching media for steels; T. E. Hamill. Price, 15 cents.
 RP372. Highly purified wood fibers as paper-making material; R. H. Rasch, M. B. Shaw, and G. W. Bicking. Price, 15 cents.

¹ Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, \$3 per year; other countries, \$3.75. Subscription to Commercial Standards Monthly, \$1 per year; other countries, \$1.25.

- RP373. Preliminary note on an automatic recorder giving a continuous height record of the Kennelly-Heavyside layer; T. R. Gilliland and G. W. Kenrick. Price, 10 cents.
- RP379. Laboratory rectifying stills of glass; J. H. Bruun and S. T. Schiektanz. Price, 20 cents.
- RP382. The determination of the coefficient of cubical expansion of solid benzoic acid by means of a gas-filled dilatometer; E. R. Smith. Price, 5 cents.
- RP388. Thermal expansion of heat-resisting alloys; nickel-chromium, iron-chromium, and nickel-chromium-iron alloys; P. Hidnert. Price, 25 cents.
- RP389. The physical properties of cast stone; J. Tucker, Jr., G. W. Walker, and J. A. Swenson. Price, 5 cents.
- RP390. Investigations of Kennelly-Heavyside layer heights for frequencies between 1,600 and 8,650 kilocycles per second; T. R. Gilliland, G. W. Kenrick, and K. A. Norton. Price, 10 cents.
- RP391. Determination of insoluble matter in shellac; C. C. Hartman. Price, 5 cents.
- RP392. Derivatives of 4-glucosidomannose; H. S. Isbell. Price, 10 cents.
- RP393. Thermal expansion of gasolines from 0° to 30° C.; C. S. Cragoe and E. E. Hill. Price, 5 cents.
- RP395. The effect of p. on the photochemical decomposition of silk; M. Harris and D. A. Jessup. Price, 5 cents.
- RP398. Volumetric determination of pentoses and pentosans; G. M. Kline and S. F. Acree. Price, 5 cents.

Commercial Standards¹

- CS30-31. Colors for sanitary ware. Price, 20 cents.
- CS32-31. Cotton cloth for rubber and pyroxylin coating. Price, 5 cents.
- CS36-31. Fourdrinier wire cloth. Price, 10 cents.

Commercial Standards Monthly¹

Commercial Standards Monthly, vol. 8, No. 8, February, 1932. Price, 10 cents. Obtainable by subscription.

¹ Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, \$3 per year; other countries, \$3.75. Subscription to Commercial Standards Monthly, \$1 per year; other countries, \$1.25.

Technical News Bulletin¹

Technical News Bulletin No. 178, February, 1932. Price, 5 cents. Obtainable by subscription.

LETTER CIRCULARS¹

- LC319. List of publications relating to photography.
- LC320. Automobile engine lubricating oils. (Supersedes LC298.)
- LC321. Rubber latex.

OUTSIDE PUBLICATIONS¹

- Superconductivity with respect to alternating currents, F. B. Silsbee, R. B. Scott, and F. G. Brickwedde, Physical Review (Corning, N. Y.), vol. 39, p. 379, January 15, 1932.
- Thermal expansion of copper alloys, Peter Hidnert, Physical Review (Corning, N. Y.), vol. 39, p. 551, February 1, 1932.
- Thermische ausdehnung von beryllium and beryllium-aluminiumbegierungen, Peter Hidnert and W. T. Sweeney (translated into German by Dr. Ing. Haas, Aachen, Germany), Zeitschrift für Metallkunde (Berlin, Germany), vol. 20, p. 225, 1928.
- The interpolation method in routine detonation testing, D. B. Brooks, Society of Automotive Engineers Journal (New York, N. Y.), vol. 30, No. 1, p. 54, January, 1932.
- Testing of aircraft engines, H. K. Cummings, The Yale Scientific Magazine (New Haven, Conn.), vol. 6, No. 2, p. 11, January, 1932.
- A hydrogen isotope of mass 2, H. C. Urey, F. G. Brickwedde, and G. M. Murphy, Physical Review (Corning, N. Y.), vol. 39, p. 164, January, 1932.

¹ Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, \$3 per year; other countries, \$3.75. Subscription to Commercial Standards Monthly, \$1 per year; other countries, \$1.25.

² "Letter circulars" are in mimeographed form and are designed primarily to answer specific inquiries. The supply is necessarily limited, so that, in general, but one copy can be sent in answer to each request. Copies are available only on application to the Bureau of Standards, Washington, D. C. No mailing list is maintained for "letter circulars" and complete sets of back numbers can not be furnished.

³ "Outside publications" are not for distribution or sale by the Government, unless otherwise noted. Requests should be sent direct to publishers.

- Chromaticity sensibility to stimulus differences, D. B. Judd, *Journal, Optical Society of America* (Ithaca, N. Y.), vol. 22, No. 2, p. 72, February, 1932.
- Effect of aging on taut rubber diaphragms, D. H. Strother and H. B. Henrickson, National Advisory Committee for Aeronautics (Washington, D. C.) Technical Note No. 409, February, 1932. (Obtainable only on application to the Nat'l Adv. Com. Aero.)
- National hydraulic laboratory will expedite research, George K. Burgess, *Research Laboratory Record* (Chicago, Ill.), vol. 1, No. 3, p. 93, February, 1932.
- Report of subcommittee on light fastness, V. Fade-Ometer tests with a Corex-D globe, W. H. Cady and W. C. Smith, *American Dyestuff Reporter* (New York, N. Y.), vol. 20, p. 754, November 23, 1931.
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